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ORGANIZATION AND MANAGEMENT OF RESEARCH ON MARINE FISH RESOURCES

by

G. R. Williams

FISHERIES DIVISION, BIOLOGY BRANCH
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1964.

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y

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MFS Provisional editions of "FAO Manuals in Fisheries Science".

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Des catégories spéciales de documents techniques sont identifiées à l'aide des symboles suivants:

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CB Listes de périodiques, des sections spéciales de la "Current Bibliography for Aquatic Sciences and Fisheries", des bibliographies particulières et des articles sur les problèmes de documentation.

MFS Editions provisoires des "Manuels FAO de la science des pêches".

Il arrive que certains documents portent d'autres numéros d'identification, comme c'est le cas s'ils ont été préparés pour une réunion dont les documents ont été marqués à l'aide d'un autre système.

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MFS Ediciones provisionales de los "Manuales FAO de la Ciencia de la Pesca".

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General

ORGANIZATION AND MANAGEMENT OF RESEARCH ON MARINE FISH RESOURCES

by

G. R. Williams

(Division of Fisheries and Oceanography of the
Commonwealth Scientific and Industrial
Research Organization, Australia)

FISHERIES DIVISION, BIOLOGY BRANCH
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, May 1964.

PREPARATION OF THIS PAPER

Originally presented as an experience paper for the FAO/IPFC Seminar on Fishery Development, Planning and Administration held at Canberra, Australia in February, 1964, this revised version is here issued for its interest to fisheries scientists and administrators other than those who attended the Seminar and outside the Indo-Pacific region.

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INTRODUCTION

In their studies of marine fish resources, fisheries scientists seek to identify and locate these resources and to measure and analyse them in their static and dynamic aspects. For these purposes resources may be defined in one of two ways -

(a) in a restrictive sense, to denote a fishable stock, or group of stocks, which may or may not yet be exploited;

(b) in a very broad sense, to denote a community or ecosystem, that is a system the elements of which include not only the species being harvested but also those on which they feed or which in some other way influence their life and behaviour: it also denotes the physical and chemical components that influence the lives of these several species.

Research upon resources restrictively defined gives a description of populations or parts of populations and permits predictions within a limited range of conditions. The direct result of this research is an estimate of the sustainable catch from each stock under various exploitation regimes; this information can be put to immediate use by 'administration' in its regulation of fishing, and by 'industry' in planning its capitalization and in conducting its operations. This research also contributes to improvement of industrial efficiency, by providing prediction systems, and by operational analysis.

Research upon resources defined in the broad sense is directed toward more detailed and refined prediction of changes in the ecosystem under various circumstances, including the effects of human intervention.

In fisheries science, as in other applied sciences, there is a constant conflict between choosing to solve immediate problems or of preparing a theoretical background from which practical advances might be made at some time in the future.

Most fishery research programmes of today are concerned mainly with the tasks relating to resources restrictively defined. It is a general opinion among fishery biologists that this kind of work should have priority in any country. This is the view taken in Australia and most of the present research is concerned with resources in the restrictive sense. No doubt, as work on the more immediate problems is completed the research effort will gradually shift to the broader field.

We can consider the organization and management of resources research under five main headings:-

1. policy direction,
2. research plan,
3. operational procedures and controls,
4. reporting results,
5. structure of the research organization.

I propose to discuss these matters with particular reference to the work of the Division of Fisheries and Oceanography of C.S.I.R.O.,* but first I need to describe generally the organization of fisheries administration and research in Australia.

Most of the Departments responsible for the administration of marine fisheries in the territorial waters of each State have small staffs engaged on marine fisheries research. In addition these Departments carry out virtually all the freshwater fisheries research in Australia.

At the Commonwealth level the Department of Primary Industry is responsible for the administration and management of fisheries outside territorial waters, and for economic and technological investigations; C.S.I.R.O. is responsible for resources research outside territorial waters (Division of Fisheries and Oceanography) and for research on fish processing (Division of Food Preservation).

A mechanism for discussion of matters of common interest and for co-ordination of activities of the various Government organizations is provided by the Commonwealth-States Fisheries Conference. This Conference meets at least once a year and has established a number of sub-committees to investigate special problems and in some cases to implement particular Conference decisions. Two of these sub-committees are concerned with fisheries research in particular regions; their terms of reference are to advise Conference on -

(a) The research programmes and other measures which should be implemented in order to achieve optimum exploitation of the resources.

(b) Practical arrangements for the co-ordination of such research programmes and other measures.

The Conference has no statutory powers but its status is such that member organizations usually are most reluctant to act contrary to a Conference recommendation.

In this paper, I am concerned only with research on marine fish resources and in this field C.S.I.R.O. and the State research units have a practical working arrangement that

- State Departments undertake research for inshore fisheries whose stocks are fished in one State only. Some States also work, usually in conjunction with C.S.I.R.O., on fish stocks which are not fished exclusively in their territorial waters;
- The Division of Fisheries and Oceanography of C.S.I.R.O. undertakes research on fish stocks which are fished outside State territorial waters or which are fished in territorial waters of more than one State.

The Division of Fisheries and Oceanography has about 30 research staff and 75 assistant and services staff. Approximately half of its research effort is on marine fish resources.

At this point it is appropriate to repeat some cautionary observations made by Professor Malecki (1963). Writing about "the transfer of foreign experience" he said -

"An extensive debate held by sections I, J and K of the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, which took place at Geneva, in 1963, proved all too clearly that:

1. The transfer of experience concerning the organization of scientific research from one country to another had to be treated with the utmost caution, and that all systematic generalizations not based on a knowledge of local conditions are likely to bring about serious mistakes and misunderstandings.

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* Commonwealth Scientific and Industrial Research Organization

2. It would be misleading to take the highly-developed countries as a whole and to draw comparisons between them and the large group of the developing countries. There are, it is true, a number of factors which often bring about unexpected resemblances between the conditions of development existing in the countries ranked in one or other of these two groups. On the other hand, different solutions are often called for in the organization of scientific research as applied to specific conditions, e.g., the availability of natural resources, in the developing countries which are more or less at the same level with regard to technical advancement and the development of scientific research.

Nevertheless it is possible to postulate some basic lines of approach, if only for a certain group of the developing countries, in the search for the most appropriate forms of organization for scientific research."

POLICY DIRECTION

C.S.I.R.O. has chosen to concentrate, for the next few years at least, on research which will lead to assessment of the sizes of certain fish stocks and to an understanding of the dynamics of the fish populations concerned. Thus the research programmes are aimed directly at providing information to assist in management and development of particular fisheries; and it is most desirable that they be planned and carried out in close co-operation with State Departments and with the Department of Primary Industry which, between them, are responsible for fisheries administration and management.

Selection of species - The species to be studied by C.S.I.R.O. are selected after consultation with State Departments and the Department of Primary Industry, either directly or through the Commonwealth-States Fisheries Conference and its Sub-committees. A number of matters must be evaluated before these decisions can be taken - the commercial importance or potential importance of the species; the extent to which research might be able to benefit the fishery; the practicability of carrying out the kind of research programme which would be required. The final decisions rest with C.S.I.R.O.

Delimitation of area of research - The decision as to the limits of the area where research is to be carried out is one in which the research officers themselves are very much concerned. I have included this item under the heading of "policy direction", however, because practical considerations of what staff, finance and facilities can be provided have a very great influence on the decision. For example, in its current studies of southern bluefin tuna, C.S.I.R.O. does not have the staff or the facilities to work in all waters around Australia where this fish occurs and so most of the field work is restricted to areas where the Australian commercial fishery operates. There are several other areas, particularly in the deeper waters, where field observations ought to be made in order to fully understand what is happening in the fishery, but this is impossible at present because a suitable research vessel cannot be provided.

Choice of resource characteristics to be studied - In this connection three situations can be distinguished -

Unused or neglected resources
Partially used resources
Ineffectively used resources.

The choice of resource characteristics to be studied will vary according to the situation. This can be illustrated by four examples of C.S.I.R.O. research programmes.

One programme is a survey of prawns in the Gulf of Carpentaria. These resources have not been exploited on a commercial scale - in fact they are almost virgin resources. We know there are prawns in the area; we do not know how abundant they are or when or where the greatest concentrations are to be found. The establishment of shore facilities and processing plants near the fishing grounds would involve considerable capital expenditure. In this situation C.S.I.R.O. set out to

make a survey of the resources with the following objectives -

1. In the area being surveyed;-

   (a) to estimate the magnitudes of the prawn stocks and their sustainable yields;

   (b) to determine the distribution of the prawns and the variations with time of distribution and abundance;

   (c) to provide a basis for predicting the effects that fishing may have on prawn stocks.

2. To define -

   (a) the physico-chemical environment; and

   (b) the types of biota

   and particularly the characteristics of these which are associated with the prawns.

3. To recommend the basis for further survey in the Gulf.

Some of these are obviously very long term objectives. Others are short term objectives which can be reached fairly quickly, perhaps within a year or two.

Tuna is an example of a partially used resource. The Australian fishery exploits only juvenile stocks. We do not know definitely how many separate stocks there are, what their sizes or areas of distribution are and, of course, we do not know how much fishing they can support. The prospects for the development of the fishery lie in a geographical extension of fishing operations and prolongation of the season; almost certainly this will require the use of different fishing techniques. In this situation the research programme has the following objectives:-

1. To identify the different stocks and determine their distribution in space and time.

2. To discover whether there are environmental indicators which can be used for fish finding and possibly for predicting occurrences of fish.

3. To estimate the sizes and maximum sustainable yields of the various stocks.

The third example, again of a partially used resource, is the Australian salmon* fishery. These fish are taken only on the beaches, which raises the important question of what proportion of the total salmon stocks finds its way to the beaches. The broad objectives of the salmon programme are similar to those of the tuna programme. The main short term objective has, however, been to determine whether there are, in the deeper waters, large numbers of salmon which are not accessible to the present fishery. The results of this investigation should show whether it is worthwhile pursuing the other objectives.

Fourthly, there is the situation in which a resource is subject to intensive fishing and we want to know the optimum level of exploitation. This is the situation in the crayfish fisheries. It is unlikely that there are any significant new grounds to be discovered. We do not know, however, whether the level of catch is above or below the maximum sustainable yield, and to determine this is the major objective of the research programme.

In all of these situations the objectives have one feature in common - to obtain information on which to base advice about the possible effects on the fish stocks of various levels of exploitation. It is important, therefore, that the objectives should be formulated in consultation with the Government Departments concerned with management and administration. If the research officer in charge of

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* This is Arripis trutta, a perch-like species. It is not a true salmon, and is not anadromous.

the programme has already been appointed he will play a major part in the formulation of these objectives, but the final decision will rest with his Director.

Now there are research workers who resist any suggestion that the objectives of their research should be written down in explicit terms. Sometimes they say this would place an undesirable restriction on the freedom of action which is essential to them. Sometimes they say it is not possible to define objectives in the early stages of an investigation and that they need time for exploratory work before they can identify the important problems.

Both lines of argument can be made quite plausible but, I suggest, both are invalid. In the first place, while some freedom of action is certainly necessary, a research worker in a Government institution cannot expect unlimited freedom to follow his own interests and to concentrate his research activity on the problems which interest him most as a scientist. He has to direct his activity in such a way as to fit in with the policy objectives of his institution. Moreover, to suggest that a restriction is imposed merely by the act of defining and writing down the objectives of the research indicates a basic misunderstanding of the concept. It implies, for example, that inflexibility is imposed by defining an objective. In fact, if this should happen, it would mean that the objective had been defined badly.

Acceptance of the second argument - we need time for exploratory work - would imply that objectives cannot be changed to meet changing circumstances. Also the argument takes no account of the fact that there can be both short term and long term objectives. There is no reason why a short term objective should not be "to obtain by carrying out exploratory work, the basic information required for the formulation of long term objectives".

I attach a great deal of importance to this matter of defining objectives, because I believe it is impossible to organize and manage a programme of fisheries research unless the objectives are clearly stated. There are usually many people associated with the programme and many activities to be co-ordinated; lack of clear objectives results in confusion and frustration.

Selection of staff - It is, in some ways, misleading to talk of selecting staff at the research level. There is seldom a queue of applicants for a position; in fact wherever there is freedom of movement, the really good research workers are not selected - rather, they select the programmes on which they would like to work and the institutions with which they would like to be associated. The success of a research institution is determined, to a very considerable extent, by its ability to attract the best research people. Nevertheless it is convenient here to refer to the process as "selection" of staff and, of course, at the lower levels there is usually a true selection process.

It is important to recognize that the nature of a research programme is very often governed by the quality, the qualifications and the interests of the research men allotted to the project. Sometimes this means that an objective with a high priority must be put aside temporarily and a less urgent objective substituted because it is impossible to find a research man who has the experience and the interest to work on the top priority problem.

The interest factor is, of course, very important in research work. It is a waste of time, money and talent to employ a research worker on a programme in which he has little interest. Within limits, it is far better for him to work on a less important problem doing work he wants to do and which he will do well. For the same reason it is often better and more economical, not to start a research programme, however important it might be, than to allocate to the programme someone who is not right for the job. In this situation it is almost certain that the research results will be of a mediocre standard, and if this should continue the reputation of the institution will suffer. This can set off a chain reaction in which it becomes increasingly difficult for the institution to attract the men required to lift the standard of the work.

Allocation of funds - Fisheries research of the kind discussed here is usually costly and, since funds are always limited, the problem of allocating money to different programmes is always with us.

It is not simply a matter of deciding on the most important programme and allocating to it the largest share of the available money. Some lines of work require the use of very costly equipment or facilities. For example, it is important for full development of Australia's tuna programme that work should be done where the mature fish occur. This would require the use of a suitable ocean-going vessel and the operating costs alone would be equal to half of C.S.I.R.O.'s present annual fisheries research budget. So, while tuna is very high on the list of priorities, this part of the work must wait.

Sometimes, on a particular programme, it is necessary to make a concentrated effort involving a high level of expenditure for a year or two. This can usually be done only at the expense of other, perhaps more important, programmes.

The allocation of funds is one of the most important functions of the director of a research organization. Since he never has at his disposal enough funds for all the lines of investigation his research staff would like to follow, he has to make choices; and the skill with which he makes these choices has a very important influence on the morale of his research staff and the level of achievement of his institution.

RESEARCH PLAN

Even when the objectives of a research programme have been clearly stated it is not always easy to decide on the lines of investigation by which these objectives are likely to be reached in the most expeditious way. Basically it is the responsibility of a research officer to decide the lines of his investigation. He is restricted by the extent of the funds, assistants and facilities available to him but within these limitations he is free to decide how he will conduct his research. His choice will be influenced by his past experience, by his knowledge of similar programmes and to some extent by intuition.

The research officer will try to plan his lines of investigation so that those which are slow to bring results (e.g. tagging) are begun as early in the programme as possible. He will ensure also that his programme is kept flexible because very often an investigation must proceed on a trial and error basis. The ability to judge when it is no longer profitable to pursue a particular line of investigation is an important quality in any research worker.

During the process of deciding on his lines of investigation the research worker considers what equipment he will require; and he must put aside any investigations which would require equipment that, for some reason, cannot be made available to him. This matter of selecting equipment can be very important and some programmes get off to a slow start because of difficulties in choosing and obtaining the equipment required. Delays of up to a year in the manufacture and delivery of special instruments are not uncommon; perhaps apparatus has to be specially modified or an entirely new piece of equipment developed; perhaps experiments have to be made to determine which kind of equipment is most suitable.

This "tooling up" phase can be a long process; but it must be done thoroughly because changes during an investigation can cause very serious delays. This is not only because of the time necessary to obtain the new equipment but also because it may take a lot of time to intercalibrate the old and the new so that the results obtained from new instruments can be written in the same terms as those from the old, or vice versa.

The relevance to the present discussion of this matter of equipment - which after all is purely a domestic problem for the research organization - is that it helps to emphasize that a research programme cannot be devised and implemented overnight. It takes time - for some programmes a very considerable time - to decide on the best lines of investigation and to "tool up". Because of this it is very necessary for those who are concerned with the initiation of research programmes - and this includes administrators - to think and plan well ahead. All too often important opportunities are lost because of a lack of forward planning. In fact many research workers have become cynical about the fact that frequently they are not asked to do anything until it has become too late.

OPERATIONAL PROCEDURES AND CONTROLS

Operational plan - Operational control is comparatively simple for a research programme carried out entirely in the laboratory. For a research programme requiring field work to be carried out perhaps 2000 miles from headquarters and involving the co-operation of individuals of many organizations, the operational system can become very complex.

The complexity of the system varies, inevitably, according to the number of people and organizations involved. C.S.I.R.O. meets three situations.

1. The whole of a particular research project is organized and conducted by C.S.I.R.O. staff;
2. C.S.I.R.O. conducts the research but receives assistance in the field work (e.g. market measuring or provision of vessel time) from State Departments;
3. The research work is shared by scientific staff and assistants from C.S.I.R.O. and from a State Department.

The first situation rarely occurs in resources research; in the second situation a detailed operational plan is desirable; in the third it is essential.

An example of an operational plan is given in the appendix. This plan is for a survey of prawn resources in the Gulf of Carpentaria, the cost of which is being shared equally by the Queensland and Commonwealth Governments. The Queensland Department of Harbours and Marine is responsible for the administration of the survey; C.S.I.R.O. is responsible for its technical supervision; the Commonwealth Department of Primary Industry is responsible for any gear technology or economic studies which may become necessary. For the resources research, some staff are provided by C.S.I.R.O. and some by the Department of Harbours and Marine.

This operational plan covers details of the research programme - objectives, lines of research, vessels, operational support, allocation of responsibility and so on - and also the administrative arrangements relating to the conduct of the survey. It is not regarded in any sense as a legally binding document; rather it is regarded as a record of the kind of things the parties to it had in mind when they were planning the survey and as a guide to how problems occurring during the course of the survey might be met. The existence of the document does not place or imply any restriction on flexibility.

I would stress the importance of preparing a document such as this during the course of the planning discussions. It is surprising how often parties to a discussion of this kind think they are all in agreement on a particular point until they come to write it down - and then find that each of them really has quite different things in mind.

Logistic support - This involves many issues - instruction of field staff, supervision of work, establishment of lines of communication, morale of field staff - some of which there is no need to discuss in detail here. It also focuses attention on the need to understand and cater for what we might call the "research temperament".

Z.M.T. Tarkowski and Avice V. Turnbull (1959) have published a paper in which they contrast the differences of temperament between administrators and scientists.

Of the scientists they say -

"It is generally known that a research scientist, if he is to be successful, must have an absorbing and almost dedicated intellectual interest in his work for its own sake. It is seldom understood how much enthusiasm is needed, even if it be of a quiet and peaceful sort, to pursue a line of investigation. Nor is it understood often enough that intellectual interest and enthusiasm, whilst in need of being tempered and moderated in order not to be allowed to get out of hand,

must at the same time be fed and sustained by continuous development and by sympathetic appreciation; otherwise it will peter out..... A scientist who has lost his intellectual interest and enthusiasm, his sense of urgency, and his scientific competitiveness is usually no longer creative."

Of the administrator they say -

"By comparison, the main preoccupations of the administrator are quite different..... In order to prevent what he considers to be mistakes, or even actions which he himself, his superiors, or his successors, might find difficult to justify, he spends considerable time thinking out all possible contingencies and repercussions, and the safeguard against them, and with experience of years, caution becomes to many second nature. He has to co-ordinate many diverse interests, such as political pressures, pressures from public bodies, requirements of the international situation, needs of industry, view of Service departments on matters of strategic importance, and many others. Needless to say, to the administrator justification of expenditure, estimates and economies are a source of constant concern. It is thus natural that 'the balanced view' becomes a watchword and that a judicial frame of mind is advocated. Quite often even contamination by enthusiasm is avoided. Should an administrator lose his detached way of looking at problems and allow himself to be swayed too much by a particular interest he is in danger of coming to be regarded as unreliable."

Not everyone will agree with the whole of the adjectives used in these descriptions, but I believe that the broad distinction made is a valid one. The essential point is that the administrator of research must give the research worker the logistic support necessary to maintain his enthusiasm and sense of urgency even though this may mean on occasions a sacrifice of what might be regarded in other situations as sound administrative procedures. Such support is particularly important for staff working in the field, where communications are not always as good as they might be. Experience has shown that in this situation it is better to make phone calls than to write letters; to send supplies by air rather than by surface transport; or to give a research worker the particular piece of equipment he prefers instead of arguing about whether something slightly cheaper would be as satisfactory.

What the administrator must do is to make sure that accounting principles are not applied in such a way as to cause a serious reduction of research incentive. It is often false economy to follow the cheaper operational procedures which might save a little money, at the expense of interrupting the programme - for idle time in a research institution is just as expensive as idle time in a factory. In a factory idle time occurs when the machines stop working. In a research institution it occurs when something happens to upset the research worker or to hold up his programme: the loss here from idle time is not as obvious as in a factory but it is just as real. That is not to say that a research worker should have only to ask to get what he wants. He is limited, of course, and he is aware of this, by the size of his research budget; and most research workers try to make this stretch as far as possible. This in itself is, in most cases, a good safeguard against irresponsibility.

This matter of providing proper logistic support is also of considerable importance in relation to assistant field staff. These are the men who are the eyes and ears of the research organization. They are the men who have the closest contact with fishermen and other operatives in the industry. Usually the research officer with whom they are working can spend only a limited time with them in the field and so it is not always possible for them to consult him immediately if unexpected situations arise. It is essential, therefore, that the field staff should understand fully the aims of the research programme and what they are required to do. C.S.I.R.O.'s experience has been that this cannot be done satisfactorily solely by verbal briefing and therefore it is developing a series of comprehensive written field instructions.

Intelligence services - Although much of the research data results from the work of the scientific staff themselves a very important part must come from the industry, including statistics of the catch taken and the effort expended in taking that catch. In addition to providing compulsory statistical data, operatives in the industry frequently co-operate with the research teams to provide detailed information on their operations. Many fishermen record this in specially designed log books

provided by the research organization. Fishermen's observations are sometimes reported daily by radio, as in C.S.I.R.O.'s tuna programme. Fishermen and fish processors frequently co-operate by completing questionnaires or by making their records available to research workers.

Another important source of intelligence is the fisheries inspectors and other Government officials who are in day to day contact with the industry. In Australia we have not yet been able to solve the practical problems of developing a simple reporting system and, more important, of laying down a set of principles to enable field officers to decide whether an event is worth reporting. Consequently many events which would be of very great interest to the research worker go unreported.

Data storage, retrieval and processing - An essential requirement in the execution of a resources research programme is an efficient system for the receipt, cataloguing and storage of data sheets received from various sources, and for the processing of those data. I do not propose to describe the procedures adopted in C.S.I.R.O., but only to refer briefly to one particular aspect of data processing, namely, the need for co-ordination of activities of the many people and organizations who provide or collect data.

The advantages of electronic computers in research, including fisheries research, are well known, but computers are useless unless we can first place the data on cards or tape, and their value in resources research is very limited if we cannot collate data collected by different people. In Australia we are trying to design a system in which the data received from various sources can be placed on cards or tape using standard code symbols. For example, the same codes are used for information collected by research workers, for information supplied voluntarily by fishermen in log books and for information on the fishermen's compulsory statistical returns. It is technically possible for all the cards onto which these data have been punched to be brought together and used in a computer programme.

It seems inescapable that as our store of data grows and as we develop further our use of electronic computers, the various Government Departments and organizations must develop standardized methods of recording data on punched cards or tape. There seem to be only two other alternatives for those situations where overlapping occurs - duplication or loss of access to relevant data: both are too costly to merit serious consideration. This points to the need to establish machinery for the co-ordination of the data collection activities of the research and administrative organizations and of the industry itself.

REPORTING

It is neither exaggeration nor an empty platitude to say that a research institution (and the individual research worker) survives, progresses or declines according to the merit of the reports it produces. Reports are to the institution and the scientist as paintings are to the artist; as loaves of bread to the baker. These are the products by which the individual and the institution are judged.

I said earlier that C.S.I.R.O. has chosen to concentrate, for the next few years at least, on research which will lead to an assessment of certain fish stocks and to an understanding of the dynamics of the populations concerned. In programmes of this kind there is a continuing need to keep industry and administrative departments informed of progress being made and of conclusions reached. In addition there is always a need, in fact a responsibility, to publish results in scientific journals. We can distinguish, therefore, three levels of reporting:-

1. Current reporting and review
2. Technical reports
3. Scientific papers.

Current reporting and review - In Australia current reporting and review is achieved in many ways. Most, if not all, of the research programmes involve close co-operation with the various

administrative departments and it is normal to report the more urgent matters by telephone, by letter or during the course of conversation when officers meet. At a more formal level, reports may be of two kinds - those submitted to the Commonwealth-States Fisheries Conference or its sub-committees; and those issued on a regular basis (some quarterly, some every six months) reviewing progress made, assessing the significance of developments during the period under review and drawing attention to any changes in the lines of investigation which might have become desirable.

As well as reporting to administrative departments it is important to report progress to the industry, particularly in circumstances where fishermen, processors and others provide essential data. In the past this has been done in Australia mainly through informal discussions with individuals or small groups, by addressing public meetings of fishermen and industry operatives and by preparing special articles for fishermen's publications. Much remains to be done, however, before the system of current reporting to industry can be regarded as adequate. In all cases where C.S.I.R.O. staff address meetings of fishermen, representatives of administrative departments attend if possible. This is to avoid the embarrassment to both the scientist and the administrator which can occur if, through a misunderstanding, the scientist is misquoted.

Technical reports - Theoretically reports should be made to those responsible for management of fisheries as soon as research results indicate or suggest that the introduction of a new management measure should be considered; or that existing management measures should be reviewed.

This implies that the research worker and the research institution know the management objectives and the factors which influenced the choice of those objectives. Just as administrators have a contribution to make in the formulation of research objectives, so do research workers have a part to play in the formulation of management objectives.

How certain should a research institution be that the conclusions drawn by its research staff are correct before it reports these conclusions officially to those responsible for management? The important thing to remember here is that in any field where research is being carried out knowledge is incomplete and often uncertain. The research worker can seldom, if ever, say that his conclusions are correct and final. An administrator who demands such finality must be doomed to a long and disappointing wait. Equally he is bound to be disappointed if he expects that conclusions reached by research workers will hold good for all time. Just as the diagnoses of doctors improve with advances in medical knowledge, so the diagnoses of fisheries biologists improve with advancement of fisheries science. What the scientist can and does say is "on the evidence available to me my diagnosis is such and such". He can then comment on the adequacy of the evidence on which he based his diagnosis and perhaps he can fix confidence limits with respect to his conclusions.

In addition to the question of when to report to 'management' there is the problem of what to report. It will be obvious to the research institution that some results, for example a stock assessment, will be of interest to 'management'. However a research institution is constantly discovering things that are, or at least seem to be, of marginal interest to 'management'. The extent to which the research institution will recognize the minor discoveries which will assist 'management' will depend on the extent to which those concerned with management have taken research workers into their confidence when formulating management policies.

An example of technical reports is C.S.I.R.O.'s series of reports on the Australian catches of humpback whales. Technical reports of this kind are usually required fairly quickly and are not submitted to the normal refereeing process which applies to scientific papers. Very often, however, a scientific paper is developed from a technical report or a series of such reports.

In the term "technical reports" I include reports for the industry as well as reports for the Government organizations concerned with overall problems of fisheries management. Sometimes a report will have to be written one way for Government organizations and another for operatives in the industry. In Australia we have not always considered the special needs of operatives of the fishing industry when preparing our reports. C.S.I.R.O. recognizes that this kind of reporting calls for the application of special skills and techniques and, in some of its other research fields,

particularly agriculture, employs staff specially trained for research liaison work. As yet, however, this specialized assistance is not available to fisheries research workers.

Scientific papers - There is no need to discuss here the purpose of scientific papers and the procedures for their preparation and publication. We do need to note, however, that they make up one part - and a very important part - of the reporting system.

STRUCTURE OF THE RESEARCH ORGANIZATION

A great deal has been written contrasting the special administrative needs of a research institution with those of an administrative Government department. I have referred to some of these special needs in this paper - e.g. in relation to recruitment of staff and logistic support. Creative research requires a special kind of environment. Contact and communion with other scientists is an essential part of that environment and, therefore, the research organization must either be sufficiently large to cater for those needs or have a close association with other research establishments. This raises an important question. When a department constituted primarily as an administrative department establishes a research group, are special arrangements necessary for effective operation of that group?

If the research group is so small that it does not warrant the creation of a separate organization there are really only two alternatives:

(1) to attach the research group to the administrative department, or

(2) to attach it to some other research organization.

Quite often the second alternative is impractical and the research group must be attached to the administrative department; however, the problem of keeping research initiative and enthusiasm alive then becomes even more difficult than in a research institution.

Another difficulty - and perhaps a more serious one - is that if a research group is attached to an administrative department, demands will almost inevitably be made for the research group to assist in matters of administration. Again this is often unavoidable but it can have serious effects. One of the qualities often attributed to research workers is singlemindedness. For many this means literally that they can concentrate effectively on only one thing at a time. These people have great difficulty in switching their thoughts quickly from one problem to another. Many administrators, to whom such 'thought switching' is normal working behaviour, find difficulty in accepting that some research workers are incapable of doing this. I have not seen any figures on the subject (possibly no study has been made) but I would not be at all surprised if one day I read that investigations had shown that for every two units of time and effort spent attending to interruptions arising from administrative needs the effective research effort was reduced by a further unit.

The kind of research worker I have just been describing usually dislikes administrative work. On the other hand there are some who tend to become interested in administrative tasks and as this interest increases they find it more and more difficult to maintain the self-discipline necessary for them to remain effective as research workers.

There are, of course, a few who can happily and efficiently handle administrative tasks without much disturbance to their research, but they are rare.

The psychology of the research worker thus becomes an important factor to consider when determining the rules and procedures which should apply to a research group located within an administrative department. Continuing on this theme I shall conclude by making four short comments on matters which I believe are of fundamental importance in this situation:

1. As far as is practicable the research group should be physically separated from the administrative branches of the department to which it belongs.

2. The Departmental heads should not expect rules and procedures which work well in administrative branches to work equally well with the research group: in fact it should be part of the Department's basic philosophy that the rules and procedures for the research group will very often need to be quite different.

3. The research group should be protected against having to spend time on administrative matters. If there is sufficient administrative work requiring technical knowledge, special staff with appropriate technical qualifications should be employed in the administrative branches.

4. If the purpose of the research group is to carry out original and creative research (as I have assumed) the salary structure and conditions of employment must be such that the Department can attract able men in competition with the larger research institutions.

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Appendix

Operational Plan

for a

Survey of the Prawn Resources

of the

Gulf of Carpentaria

Prepared: May, 1963

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INTRODUCTION

This document sets out plans for the conduct of a survey of the resources of prawns in the Gulf of Carpentaria. This survey was requested by the Treasurer of Queensland in a letter of 24th October, 1962 addressed to the Minister for Primary Industry which described the issues to be resolved as follows:-

(a) The extent of the fishery opportunity and the period in each year when that opportunity could be exploited;

(b) The type of vessel required for the fishery and the most suitable type of gear;

(c) The local centres which would be the most likely point for development of the industry;

(d) Whether the industry should be developed dominantly for export purposes or for an enduring component of local consumption;

(e) Whether export should be organized from a Gulf port; if not, the form of intermediate transport to the export point;

(f) As the Gulf is a combination of both State and Commonwealth waters - predominantly the latter - the steps which should be taken for unified control measures; and

(g) Whether there should be an initial conservation programme and, if so, the method of its application and enforcement.

The plans described here relate to a resources survey whose results will be descriptive of the resources and relevant chiefly to issues (a), (f) and (g). Some experimentation in gear technology will be possible and provide information relevant to issue (b); the survey will provide some information relevant to issues (c), (d) and (e) but resolution of these problems will require economic investigations.

1. RESEARCH PROGRAMME

1.1 Objectives

A. In the area being surveyed:-

(a) to estimate the magnitude of the prawn stocks and the sustainable yield;

(b) to determine the distribution of the prawns and variation with time of the characteristics of distribution and abundance;

(c) to provide a basis for predicting the effects that fishing may have on prawn stocks;

(d) to recommend the appropriate bases for management measures.

B. To define:-

(a) the physico-chemical environment; and

(b) the types of biota associated with the prawns.

This information will be of value to fishermen in their searching for prawns, to the research workers in their study of exploited prawn populations and to those who may engage in further prawn survey work.

C. To recommend the basis for further survey in the Gulf of Carpentaria.

1.2 Plan of Operations

1.21 Area. The area selected for survey is the south-east corner of the Gulf of Carpentaria - bounded approximately in the north and west by lines running due east from the north-east point and due south from the south-west point of Mornington Island. This is approximately 10,000 sq. miles in area.

The total area of the Gulf is more than 100,000 sq. miles and even spot sampling of such an area would either take many years or many vessels. In planning a survey in which one survey vessel will be available for two years choice had to be made of an area which a single vessel might usefully sample in two years.

The decision to choose the south-east corner of the Gulf was greatly influenced by information that a commercial operation with about a dozen vessels would be carried out in this area and that the operators concerned would willingly co-operate in the survey. These operators had already made a preliminary examination and established that prawns were present.

1.22 General Statement of Methods and Arrangements. The survey is conceived as a prospecting operation conducted on a broad scale by a survey vessel and, in intensive fashion, by a group of commercial fishing vessels, the two components being closely integrated.

The operation of the survey vessel will be in the nature of spot sampling wheras the commercial vessels will make a more intensive testing of the stock abundance at selected sites.

The location of individual operations of the vessels will be determined by the following plan.

(a) The area will be divided into zones based on physical and biological characteristics of the area (depth, type of bottom, etc.).

(b) Each zone will be divided by a grid system and operations will be carried out to sample each grid rectangle systematically. The extent of sampling by the survey vessel will be of the order of 5-7 sampling operations per year in each grid rectangle, but the actual frequency might differ between zones.

(c) Initially a number of transects will be made to obtain basic information for subdividing the area.

Some sampling of catches will be made on the mother ship, from which also, detailed processing data will be obtained. A shore-base for the survey team will be set up at Karumba to permit sorting, storage and despatch of material and initial handling of records. Laboratory operations will be carried out at Brisbane (Department of Harbours and Marine) and Cronulla (C.S.I.R.O.). Arrangements may be entered into with Universities and Museums for identification of material collected in the course of the survey.

1.23 Time Scales. The initial plan is for a two year survey. The first operations in 1963 will be carried out from about July 1, and the commercial operators expect to work to a season ending about November.

The work of this period must be regarded largely as a reconnaissance to establish whether or not the area is occupied by substantial stocks of prawns during the part of the year over which the survey has been conducted. If prawns are not located in substantial quantities during this period the reconnaissance phase will be continued in this area until the twelve months cycle has been completed. If positive signs should not be found within the area, similar reconnaissance operations will be carried out in other parts in the Gulf. When substantial stocks of prawns have been located, phase two of the research programme will be commenced.

1.3 Lines of Research

1.31 Initial Phases. In formulating plans for the initial work of the survey, care has been exercised to select within the limitation of staff, equipment and the survey vessel only those activities essential to the immediate purposes of the survey as set out in Section 1.1.

A. Prawn Populations

Taxonomy

(a) A reference collection of prawns from northern Australia will be sought from Dr Racek, University of Sydney or from the Curator of Crustacea at the Australian Museum, who will be asked also to check identifications made by each person on the survey team;

(b) Collections will be made of prawns which cannot be identified from the reference collection; these will be despatched to the person providing the reference collection.

(c) Costs in connection with preparation of the reference collection, transport of reference collection, identified material, and the material collected as under (b) must be met from the survey fund.

Distribution and Movements. Apart from tagging operations (discussed below) the work in this line will consist of making synoptic presentation of data derived from the fishing logs and from the records of the survey vessel, with regard to size, species and sex composition of the catch.

Growth and Recruitment. This study will require the taking of numerous samples for measuring (as well as identification and notation of sex, etc.) so as to provide data on length and weight composition of the population. Samples for this purpose will be taken from every haul made by the survey vessel and from the commercial catch according to an agreed plan. Tagging operations (see below) will furnish more direct information on growth.

The juvenile stages, of species of prawn found in the Gulf, live in the rivers and littoral areas; for a full assessment of the prawn stocks of the survey area the juvenile populations must be measured. Proposals for work of this kind will be made at the end of the first phase.

Reproduction. Study of fecundity, gonad cycle, spawning place and time: for this study small samples will be taken from the catches of the survey vessel; and supplementary samples will be taken from the commercial catches where these differ in composition from the catches of the research vessel. These samples will be examined for sex and sexual condition, and gonad specimens will be taken for histological examination. A few fully ripe gonads will be taken, for each species, to be weighed and teased out for fecundity study.

Population Dynamics. Data on the structure of these populations will be obtained from several of the lines of study described above; data on dynamic aspects such as mortality will also be drawn from these lines but more especially from an analysis of the results of commercial operations. This material will be under constant close scrutiny involving the use of computational equipment and the results of this work will be made available promptly for the continued guidance of the survey.

B. Prawn Habitat

Oceanography. Observation will be made of surface and sub-surface temperature and salinity. Full-scale hydrological surveys at appropriate intervals, and using a frigate, will be requested.

Arrangements should be made to obtain temperature and salinity observations at the site of commercial operations, especially when the commercial fleet is not accompanied by the survey vessel.

The fishing vessels' log books will provide for recording observations of various oceanographic phenomena.

Bottom Sediments. The fishing vessels will be asked to record, in their logs, the type of bottom over which their nets are hauled on each occasion; bottom type will be indicated in general terms "mud", "sand", etc. If practicable a programme of sediment study will be carried out, and the assistance of C.S.I.R.O. Division of Soils in both planning and implementation of the programme will be sought.

Biota. The survey vessel will measure the total weight of each catch; the weight of the prawn catch will be measured directly, and the weight of the non-prawn catch will be recorded as the difference. An aliquot, representative of the non-prawn catch, will be taken, sorted and preserved according to instructions provided. The Museums and Universities will be asked to assist in this work; in the first place they will be asked to provide authoritative identifications of the species found and then to establish reference collections; subsequently they may be able to assist in developing a system for reliable identification of the communities from which prawn catches are taken.

1.32 Second Phase. This phase will include lines of research described in the first phase, and in addition:-

Tagging. A tagging programme would be designed to provide information on:-

(1) the contribution of river and coastal prawns to trawl-ground populations;

(2) the movements of prawns;

(3) growth;

(4) assessment of population size.

Inshore Collection. Shallow draught boat operations would be required to:-

(1) carry out the inshore and river tagging;

(2) survey the distribution of developmental stages.

Turbidity. These studies would be directed to assessing the effects of suspended material, light penetration on the concentration of prawns and testing the shipboard identification of the so-called mud-boils believed to identify concentrations of banana prawns.

Mid-water Trawls. Japanese fishermen are achieving remarkable results using mid-water trawls. Their use may be tested as a means of increasing the accessibility of the stocks of the fishermen; but also as a means of increasing the understanding by the research teams of the distribution of the stocks.

1.33 Extension of Survey. Although the work described above may be expected to furnish information on which to base developmental plans (if the stocks will support these) and management action (which will be necessary if development is possible), it

will not provide a full description of the resources for the purposes of prediction and long-term management. Both background and directed research will be required for fisheries in the Gulf, as are required elsewhere for established fisheries. Four main categories of further work can be indicated:-

1. Survey in other parts of the Gulf (this would follow the lines of the present survey and make use of its results).

2. Population work on each stock under exploitation (this is a continuing monitoring operation).

3. Background research into matters such as prawn behaviour, parasitology and embryology.

4. Research in gear technology (e.g. use of underwater sound in prawn fishing), food technology and economics.

1.4 Survey Vessel

1.41 Specifications and Equipment. The vessel to be chartered for use during the survey should be the most suitable prawn trawler offered at the time. To meet operational requirements it should be:-

(a) Capable of carrying out normal commercial trawling operations in the survey area and of holding the catch in a marketable condition.

(b) Capable of cruising at not less than 7 knots.

(c) Seaworthy and in first class condition. (A survey examination will be required.)

(d) Crewed, rigged and equipped to stay at sea for periods of up to seven days.

(e) Have accommodation for 3 scientific personnel in addition to the crew.

(f) Fitted with echo sounding gear.

(g) Fitted with two-way radio.

1.42 Contract. The charter party contract should provide for the following:-

(a) the initial period of charter shall not extend beyond December 1963;

(b) termination on agreed notice by the Government should conditions be found to be such as to require a change to a smaller or larger vessel;

(c) the vessel must be under the charge of a skipper having experience to the satisfaction of the charterer;

(d) all fishing gear, fuel, ship's supplies (including victuals for scientific personnel) are to be provided and/or maintained by the contractor;

(e) additional equipment, both fishing and scientific, may be placed on board and such modifications made to the vessel and deck lay-out as may be necessary for this purpose - the cost to be met from the survey fund;

(f) prawns caught shall be the property of the charterer (and the proceeds from any sales paid to the survey fund);

(g) approved emergency stores and safety equipment;

(h) the operations will be carried out under the direction of the scientific leader or his deputy, subject to the skipper being responsible for the safety of the vessel.

1.43 Staff. The vessel will carry one or two Technical Assistants at all times and sometimes a Research Officer, in addition to the normal working crew.

1.5 Co-operation with Commercial Vessels

Operational Integration. To maximise the research effort, the operations of the survey vessel must be integrated with those of commercial fishing vessels in the area. This means that close liaison must be maintained with commercial operators; and the overall survey plan must be kept flexible to fit in with changes in the pattern of commercial fishing. All research data, when processed, will be made available to commercial fishermen.

Observations to be Made and Records to be Kept. A log book will be issued to the skipper of each commercial vessel in which he will be asked to record particulars of every haul made (see section 1.92).

A specification of commercial vessels and their equipment will be made at the beginning of the operations, preferably by a gear technologist and arrangements made to document any changes to these specifications.

Collections to be Made. Initially each trawler will be asked to put aside, in a specially numbered bag, a sample of the prawn catch from each haul. The exact nature of the sampling pattern will be decided at a later date in the light of experience. Balances may be provided to commercial vessels to enable them to record total weight of catch per haul.

At least one of the commercial vessels will be asked to take water samples and record temperatures, particularly when the survey vessel is working in a different area.

1.6 Aerial Observations

Within limitations imposed by the Director of Civil Aviation, chartered flights will be made over the survey area to locate patches of discolouration of the sea water of which the cause might be prawn activity. Arrangements will be made to photograph such phenomena with colour-film, and, if possible, personnel in the aircraft should include one of the commercial operators. The location of these patches will be communicated immediately to the survey vessels to enable confirmatory sampling or exploitation to be made, and an initial series of flights should be made during the first fortnight of commercial operations. The frequency of further flights will be determined by the results achieved by the initial series.

1.7 Operational Support

The efficiency, and safety, of this survey can be greatly increased if a number of special services can be provided. These include:-

(i) weather information;

(ii) radio - communications;

(iii) navigational and direction finding; and

(iv) arrangements for operational conference.

(a) Arrangements should be made for weather reporting and forecasting to Karumba and for dissemination of this information to the vessels. The vessels themselves should make weather reports. Approach should be made to the Weather Bureau in this connection.

(b) The mother ship will have a radio set for communication with the vessels and with outside stations; each vessel must have two-way radio.

(c) Navigational guides are being re-established in the Norman River. Special arrangements must be made for locating each operation by survey and commercial vessels; these must include use of radio direction-finding equipment and probably will involve use of special marker buoys on identified fishing grounds.

(d) There should be regular conferences between the survey staff and the fishermen.

1.8 Allocation of Responsibilities for Research Programmes

C.S.I.R.O.

(a) Technical Direction of Survey.

(b) Provision of research services (histology processing; data processing).

(c) Lines of research on population dynamics, distribution and movement, habitat.

Department of Harbours and Marine

(a) Periodic responsibility for field work control in absence of scientific leader from field headquarters at Karumba.

(b) Lines of research on reproduction, growth and recruitment.

Department of Primary Industry

(a) Specification of fishing gear on survey and commercial vessels used in exploratory fishing.

(b) Research in gear technology - modification of gear to suit Gulf conditions. (See section 1.33).

(c) Research into the economics of the Gulf prawn fishery. (See section 1.33).

1.9 Data Sheets and Field Instructions

1.91 Log Sheets and Field Records Kept by Scientific Staff.

(a) Aboard Survey Ship

(1) Trawling log as supplied to commercial vessels.

(2) Station log. This would include number and kind of observations at each station. Details of samples made including sample identification numbers, salinity/ temperature records, etc., biota weight, prawn weights, etc.

(3) Length frequency record sheets.

(b) Shore Work

(1) Record sheets (commercial boat samples).
(2) Record sheets for taxonomic samples.
(3) Record sheets for length-weight samples.
(4) Record sheets for gonad samples.
(5) Record sheets for bottom sediments.
(6) Record sheets for biota samples

1.92 Log book for commercial fishermen. This should be designed so that as far as possible information in the log can be carded on IBM cards with a minimum of coding transliteration. Information will include for each shot: position of haul, depth, weather, current direction, ship direction, duration of haul, sea temperature, weight of trash, type of trash, catch of prawns by species.

1.93 Instructions to Field Staff (to be prepared by C.S.I.R.O.)

(1) Introduction - to include:-

(a) purpose of the survey;

(b) place of the field staff in the survey.

(2) Responsibilities of field staff, including standards of behaviour.

(3) Tropical hygiene.

(4) Instructions on survey station procedure and survey station logs and records.

(5) Instructions on shore station procedure and shore station logs and records.

(6) Instructions on sampling, labelling and preserving and packing.

(7) Instructions on measuring, weighing, etc.

(8) Instructions on procedure to check samples received from boats.

2. ADMINISTRATIVE ARRANGEMENTS

2.1 Co-ordinating and Review Committee

The Minister for Primary Industry has agreed with the Queensland Treasurer's suggestion that C.S.I.R.O. be given responsibility for technical supervision of the survey and that the Department of Harbours and Marine have responsibility for the administrative arrangements.

Many aspects of the survey will require close collaboration between the Department of Harbours and Marine, C.S.I.R.O. Division of Fisheries and Oceanography and the Department of Primary Industry. To facilitate this collaboration a Prawn Survey Committee should be established, comprising representatives of the three organizations and such others as may be found necessary for the work of the Committee. The Department of Harbours and Marine should provide the Secretariat and the Department's representative on the Committee should be the convener.

The Committee's terms of reference should be to:-

1. Co-ordinate the administrative arrangements for the conduct of the survey.

2. Receive and distribute progress reports on the survey, and be available for consultation on the nature of the survey operations.

3. Prepare a final report to the respective Governments on the results of the survey.

4. Advise the respective Governments of the developmental prospects in the Gulf.

5. Advise the respective Governments on the management of the Gulf prawn fishery.

Pending the formation of such a Committee the representatives of three organizations named above have considered a number of administrative matters requiring immediate attention and comments on these are given below.

2.2 Financial Arrangements

2.21 Charter Parties. The Department of Harbours and Marine, in consultation with the Prawn Survey Committee, should be responsible for the negotiation and administration of agreements for the charter of vessels and aircraft.

2.22 Payment of Monies. Department of Primary Industry will make regular advances to the Department of Harbours and Marine from the Fisheries Development Trust Account. Whenever possible all accounts should be paid by the Department of Harbours and Marine. It will be necessary for C.S.I.R.O. to make payments and recover the amount from the Department of Harbours and Marine.

2.3 Co-ordination of Work

2.31 Appointment of Scientific Leader. C.S.I.R.O. should nominate the scientific leader. C.S.I.R.O. has indicated that the leader will be Dr J.M. Thomson.

2.32 Collaboration with Universities and Museums. Dr Thomson should investigate the possibility of assistance from Universities and Museums with the research work - particularly with prawn taxonomy and faunistic studies.

2.33 Progress Reports. The Scientific Leader should submit progress reports to the Prawn Survey Committee at quarterly intervals. In addition he should submit to the Committee at monthly intervals details of the survey vessel's operations.

2.34 Scientific Papers. Preparation and authorship of scientific papers should be subjected to the rules applying to C.S.I.R.O. or the Queensland Public Service.

2.4 Management of the Fishery

Having regard to the absence in the Gulf of normal shore facilities, the Department concerned should examine their legislation to see what control measures could be exercised to prevent fishermen who do not have adequate supporting facilities from operating in the Gulf, and later to control the number of vessels operating in such a way as to obtain the maximum sustainable yield from the prawn stock.

2.5 Cost of Survey

At this stage insufficient is known of the conditions which will be encountered to be able to make a detailed estimate of costs. A preliminary examination suggests that the main costs will be of the following order of magnitude:-

	£
Charter of vessel ...	24,000
Charter of aircraft ...	2,000
Salaries of assistant staff specially recruited for the survey ...	6,000
Travelling allowances ...	6,000
Fares ...	4,000
Gear and equipment ...	2,000
Transport of gear and equipment ...	4,000
Contingencies ...	2,000
	£50,000

These estimates make no allowance for revenue from sale of prawns caught by the survey vessel.

By the end of 1963 it should be possible to make a more accurate estimate of costs.

FAO FISHERIES TECHNICAL PAPER

This is one of a series of Technical Papers (see inside front cover) dealing with aspects of the work of FAO Fisheries Division, Biology Branch, including the review of pertinent information on particular topics, to meet the request for assistance, for presentation to technical and scientific meetings, etc. Extra copies can be obtained by application to:

Research Programs Section
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FIb/T15	A list of Inland Fishery Workers in Europe	April, 1964
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FIb/T30	Notes on the identification of sub-populations of fish by serological and biochemical methods, the status of techniques and problems of their future application	April, 1964
FIb/T37	A bibliography on the pituitary gland and its relation to the fishes in nature and in captivity.	April, 1964
FIb/T40	Manual of methods of fish population analysis	April, 1964
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